KPAJOURNAL

VOL. 2, NO. 3

A 10 October 2005 *DigitalGlobe* satellite image showing a single new K-300 SSC (right center)—approximately 39 m long—berthed between two shorter 34 m SANG-O SSC in a dry dock at the Chunghung-man Navy Base on Mayang-do (i.e., Mayang Island). Two ROMEO class SS are seen deeper (left) in the dry dock. (*DigitalGlobe*)

Contents

KPN Deploys New Version of SANG-O Class Coastal Submarine[1]

By Joseph S. Bermudez Jr.

Background

During mid-March 2011 Republic of Korea (ROK) officials revealed that the Korean People's Navy (KPN) had developed and been operating a small number of new coastal submarines (SSC) for "several years."[2] These new submarines, tentatively identified as the K-300 class or possibly SANG-O II class, are apparently based upon the older SANG-O class SSC.[3]

The original SANG-O class, which entered service around 1991, is 34 m x 3.8 m, displaces ~275 metric tons surfaced and has a speed of 7.2 knots surfaced and 8.8 knots submerged. This vessel was based upon a combination of Yugoslavian designs, an earlier experimental 41-METER class auxiliary or research submarine (SSA), practical knowledge acquired in constructing the ROMEO class (i.e., Chinese Type-033) fleet submarine (SS) and 30+ years of operational submarine experience. It has been built in two major versions—a standard attack version for the KPN armed with torpedoes or mines and a reconnaissance (e.g., infiltration) version for the Reconnaissance General Bureau's Maritime Department which had the torpedo tubes replaced by a diver lock-out chamber. By the early 2000s the SANG-O class SSC had replaced the elderly WHISKEY class SS entirely and

The SANG-O SSC (reconnaissance version) that was captured by the ROK off Kangnung in 1996. It is now on display above the beach where it was captured. (Joseph S. Bermudez Jr.)

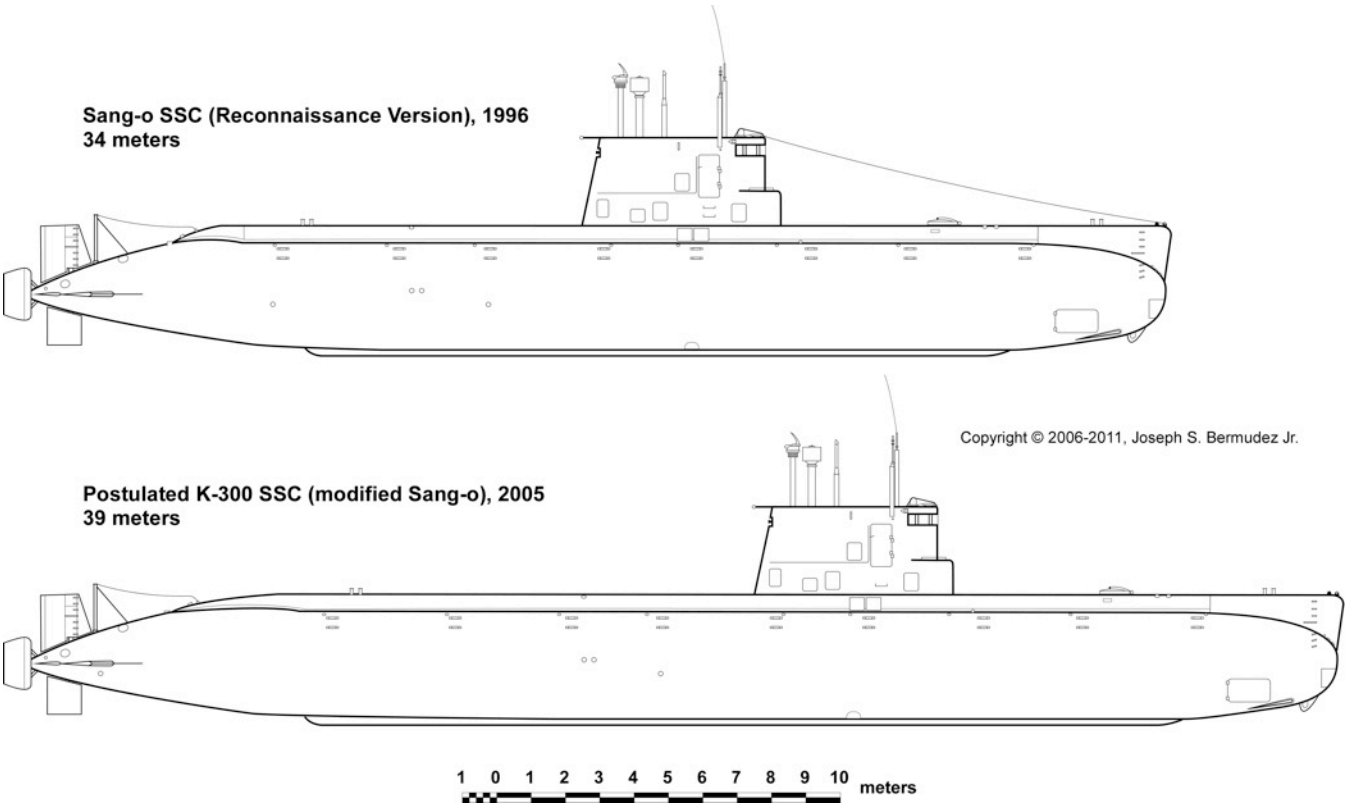
superseded the ROMEO class SS as the KPN's primary submarine.[4]

The reconnaissance version of the SANG-O is used to clandestinely insert special operation forces (SOF) troops and intelligence agents into the ROK and Japan. For example, a SANG-O class SSC from the Maritime Department's 22nd Combat Squadron was captured by the ROK after running aground at Kangnung in 1996. In the subsequent 49 day search for the grounded crew members and passengers eleven committed suicide, thirteen were killed in firefights, one was captured and one successfully evaded back to the Democratic People's Republic of Korea (DPRK). Examination of the captured submarine revealed that it was equipped with a high percentage of off-the-shelf commercial communications and navigation equipment.[5]

Close-up of the masts and antennas on top of the sail of the SANG-O SSC captured off Kangnung in 1996. (Joseph S. Bermudez Jr.)

Yi Kwang-su (a.k.a., Li Kwang-su)—the captured helmsman from the SANG-O class SSC—stated during debriefing that the KPN had recently begun construction of a new 1,000-ton class reconnaissance submarine at the Pongdae Boiler Plant in Sinp'o, Hamgyŏng-namdo, on the East coast.[6] This project was initiated at the recommendation of 22nd Combat Squadron for a vessel capable of greater range, endurance and capacity then the existing SANG-O class. The new boat was to have a capacity to carry 80 personnel (including the crew). Yi also stated that the Maritime Department had begun recruiting and training crew from the 22nd Combat Squadron and other naval units for this new submarine since May 1996. Little else is known publicly concerning this project—whether it was completed, whether it was successful, etc.

Regardless, during the late-1990s or early 2000s a decision was reached to design a modified version of the SANG-O SSC. Construction of the new submarine likely commenced shortly afterwards during the early to mid 2000s. A satellite image acquired by *DigitalGlobe* on 10 October 2005 suggests that the new submarine likely entered KPN service during or prior to 2005. This image reveals two of the new submarines—one in dry dock (39° 59' 53.69" N 128° 12' 00.04" E) at the Chunghung-man Navy Base on Mayang-do, Hamgyŏng-namdo and one at the Yuktae-dong Navy Base (40° 01' 30.78" N 128° 09' 55.38" E), Yuktae-dong, Hamgyŏng-namdo. The imagery indicates that the new 39 m x 3.8 m submarine was developed by inserting a 5 m long section aft of the sail (published sources variously report the



A scale drawing of the reconnaissance version of the original 34 m SANG-O SSC (top) that was captured off Kangnung, ROK, in 1996 compared with a postulated drawing of a stretched 39 m K-300 version (bottom). It is presently unclear whether the K-300 has a shrouded prop. (Joseph S. Bermudez Jr.)

length of the new submarine as 39 or 40 m). If reported estimates of a submerged speed of 13 knots are correct it implies that some of this added space is being used for an improved diesel-electric power plant. The additional space is also likely to improve seaworthiness, patrol range and carry larger numbers of SOF troops for infiltration mis-

A 10 October 2005 Digital Globe satellite image showing a 39 m K-300 SSC berthed at the Yuktae-dong Navy Base. Note the security wall on the piers to prevent direct observation of the enclosed harbor. Although not seen in this image, a disturbance in the water across the opening to the inner harbor is sometimes visible suggesting a floating barrier or possibly an anti-infiltration barrier. (*DigitalGlobe*)

sions. Estimates for the new submarine's surface displacement range between 300-340 metric tonnes. Given what is known concerning the standard SANG-O class SSC, and other KPN submarines, an attack version of the new model is likely armed with four 533 mm torpedo tubes and is capable of carrying 16 sea mines. A reconnaissance version could possibly have room for a total complement of 35-40 (crew and SOF troops) depending upon equipment carried and length of voyage.

At present, the new submarines have been identified at the Ch'aho-rodongjagu, Mayang-do and Yuktae-dong Navy Bases, all on the East Sea (a.k.a., Sea of Japan). The primary KPN submarine base on the West Sea (a.k.a., Yellow Sea) is at the Pip'a-got Navy Base. Satellite imagery of Pip'a-got obtained by *DigitalGlobe* on 11 March 2011 reveals four ROMEO class SS (one in dry dock) and seven smaller SANG-O class SSC but none of the new submarines.

Overall inventory estimates for KPN submarines have remained relatively steady at around 70 vessels during the past ten years.[7] If these estimates are correct, it suggests that older submarines are being retired (note the two ROMEO class SS being dismantled in the image of the dry dock above) and replaced by newer SANG-O and K-300 class boats in an effort to maintain the size of the submarine fleet rather than expand it. An additional possibility is that some of the existing SANG-O class submarines may be undergoing modification to produce the new K-300. It is presently unclear whether the new class has superseded the original SANG-O on the production lines, however, this may be the case.

Exercises

As part of the annual training cycle the KPN routinely conducts naval exercises in both the West Sea (i.e., Yellow Sea) and East Sea (i.e., Sea of Japan) during March and April as the weather and sea temperature rise. Integral component of these exercises are submarine operations, which simulate infiltration and attack missions. During such exercises the submarines, sometimes with a support vessel, may remain at sea from three to five days. According to ROK Ministry of Defense officials the March-April 2011 submarine exercises are at a slightly higher tempo than previous years with the KPN "...mobilizing five or six subs including new Shark-class [SANG-O class] ones from naval bases on the East and West coasts."

The Korean People's Air Force in 1953[8]

By Joseph S. Bermudez Jr.

While the Korean People's Air Force (KPAF) conducted a number of small operations during the opening phases of the Fatherland Liberation War (i.e., Korean War) the intervention of the United Nations Command (UNC) air power quickly eliminated it as a combat effective force. This, combined with the UNC advance north of the 38th Parallel and capture of most KPAF air bases, forced the remnants of the service to retreat north into Manchuria. Here it engaged primarily in rebuilding, reequipping and modernizing with the aid of Soviet and Chinese Air Forces. With the exception of night heckler raids using Po-2 biplanes and Yak-18 trainers and a small number of combat air patrols over northwestern Korea (i.e., "MiG Alley") the KPAF did not significantly contribute to air combat operations during the remainder of the war due to a decision by Kim Il-sung to allow the Chinese and Soviets to bear the brunt of combat and save the KPAF for the future.

Beginning in 1948 large numbers of young men were inducted into the KPAF and sent yearly to the Soviet Union for two years of training as aeronautical engineers and pilots to become the backbone of the future KPAF. These were to form the backbone of the KPAF. When they began returning in mid 1950 the war had started and they became mid-level commanders and instructors for the decimated remnants of the KPAF reorganizing in Manchuria. Although some training for KPAF personnel continued in the Soviet Union the vast majority was transferred to Manchuria where over the next two years several thousand KPAF personnel received technical and flight training. During 1951 the Soviet Union delivered replacement equipment and aircraft—most notably the MiG-15.

These personnel and equipment allowed for a modest reorganization and expansion of the KPAF. By the end of 1952 the KPAF consisted of a headquarters, air academy, aviation school and two air divisions—1st Air Division and 2nd Air Division. The 1st Air Division was reorganized around newly delivered MiG-15s, having an estimated authorized strength of 74 MiG-15bis and an actual strength somewhat less than this. The majority of the piston-engine aircraft were consolidated in the recently established 2nd Air Division.

As 1953 dawned the KPAF was positioned, with personnel and equipment, for a major reorganization. This reorganization unfolded during the first nine months of 1953 in the following sequence:

- The 2nd Air Division's assortment of piston-engine aircraft was relegated to training duties and the unit initiated preparations to receive the MiG-15bis.
- Approximately 40 Il-28 jet light bombers were delivered and Soviet advisors initiated a Il-28 transition training for KPAF pilots.
- Shortly thereafter the 2nd Air Division, which still had many of its piston-engine aircraft, commenced transition training to the MiG-15. The unit's piston-engine aircraft were subsequently assigned to the recently established composite 5th Air Division.

- Concurrently the 3rd Air Division was established and equipped with the MiG-15bis.
- The newly acquired Il-28s became the nucleus of the newly established 4th Air Division, the strength of which was supplemented by the delivery of approximately 30 piston-engine Tu-2D/F light bombers.
- Immediately after the signing of the Armistice Agreement the KPAF formed the majority of its piston-engined aircraft (Yak-9P, Il-2, Po-2, Yak-11 and Yak-18 aircraft) into the composite 5th Air Division with three air regiments.
- During August and September 1953 the KPAF initiated the large-scale redeployment of aircraft from Manchurian bases to rebuilt or newly constructed airfields within the DPRK. This was accomplished both by flying the aircraft south and by shipping them by rail on flatcars.

During May 1954 U.S. Air Force intelligence estimated the January 1953 and January 1954 aircraft strengths of the KPAF as:

Aircraft	1 January 1953	1 January 1954
MiG-15bis	60	150
Yak-9P	70	30
IL-2	20	30
Il-28	40	40
Tu-2D/F	--	30
Total	190	300

A 1998 DPRK stamp of the Hydrometeorological Service headquarters in P'yŏngyang. (Don Hillger)

The Hydrometeorological Service

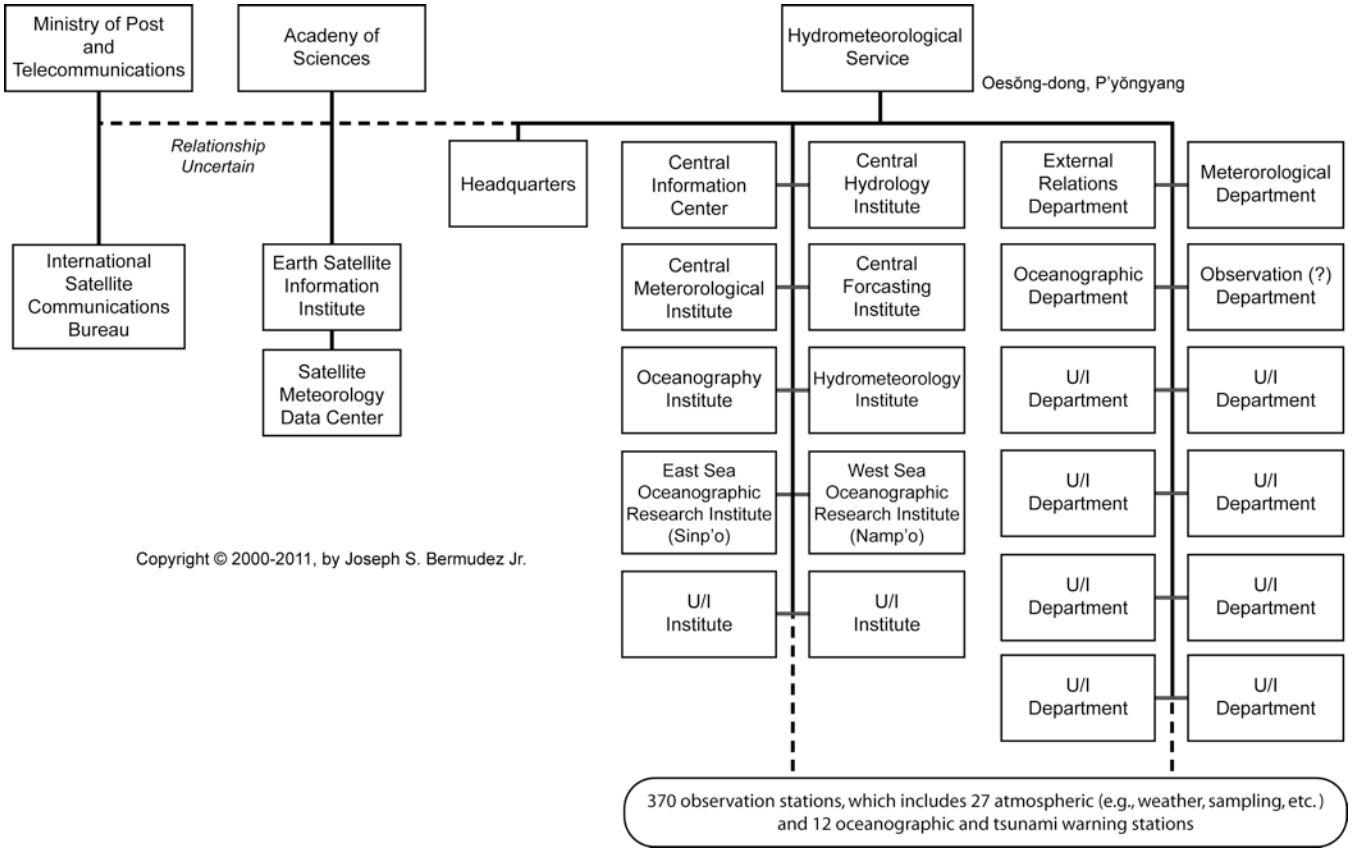
By Joseph S. Bermudez Jr.

The Hydrometeorological Service (a.k.a., Hydro-Meteorological Service or National Hydrometeorological Administration) of the DPRK was established in P'yŏngyang during 1946 as the Hydrometeorological Bureau.[9] Subsequently renamed the Hydrometeorological Service (HMS) it is "...an organ directly under the authority of the Cabinet."[10] During the 1960s-1980s the Hydrometeorological Service (HMS) focused a considerable amount of its resources into observing and reporting on the "…wonderful natural phenomena on Mt. Paektu..." and other revolutionary locations. During the late 1990s these resources were gradually refocused to more practical activities and today the HMS is responsible for providing the nation with weather forecasts, storm (e.g., typhoons, etc.) warnings, atmospheric monitoring and maintaining "an early warning system" for the "development of the national economy and protection of the lives of the people."[11] It also provides advanced analytical and monitoring support to the General Staff Department's Geological, Nuclear-Chemical Defense and Ballistic Missile Training Guidance Bureaus, as well as the Korean People's Air Force and Navy. Such assistance is especially important during nuclear tests, nuclear accidents (e.g., April 2011 Fukushima nuclear accident), satellite launch attempts, operational planning, etc. It would also be critical for any long-range missile operations during a future conflict.

The HMS's interest in satellite launches may be seen by the April 2009 statement by the director of the Central Meteorological Institute, Ko Sang-pok, supporting the launch of the "experimental communications satellite" Kwangmyŏngsŏng 2 aboard the U'nha 2 space launch vehicle.[12]

Headquartered in Oesŏng-dong (a.k.a., Oesong-dong or Oeso'ng-tong), P'yŏngyang-si (39° 00' 43.26" N 125° 44' 46.33" E), the HMS has been under the directorship of Ko Il-hun since at least 2005. The HMS is reportedly organized into twelve departments, approximately ten research institutes and one satellite ground station (located in P'yŏngyang). These organizations oversee approximately 370 nationwide observation stations, which include 27 atmospheric (i.e., weather and sampling), 12 oceanographic and tsunami warning and an unknown number of geodesic (i.e., earthquake) stations.[13] During 2006, of the HMS's 27 atmospheric stations only two are upper-air capable and according to open sources the majority are collocated at KPAF air bases.[14]

Anju	39° 37' N	125° 39' E	47050
Changjin	40° 22' N	127° 15' E	47031
Changjŏn	38° 44' N	128° 11' E	47061
Chŏngjin	41° 47' N	129° 49' E	47008
Chunggang	41° 47' N	126° 53' E	47014
Haeju	38° 02' N	125° 42' E	47069
Hamhŭng *	39° 56' N	127° 33' E	47041
Hŭichŏn	40° 10' N	126° 15' E	47039
Hyesan	41° 24' N	128° 10' E	47016
Kaesŏng	37° 58' N	126° 34' E	47070



Organization of the DPRK's Hydrometeorological Service, 2011 (Joseph S. Bermudez Jr.)

Kanggye	40° 58' N	126° 36' E	47020
Kimch'aek	40° 40' N	129° 12' E	47025
Kusŏng	39° 59' N	125° 15' E	47037
Namp'o-si	38° 43' N	125° 22' E	47060
P'ungsan	40° 49' N	128° 09' E	47022
P'yŏnggang	38° 24' N	127° 18' E	47075
P'yŏngyang-si *	39° 02' N	125° 47' E	47058
Ryongyo'n	38° 12' N	124° 53' E	47068
Samjiyŏn	41° 49' N	128° 19' E	47005
Sariwŏn	38° 31' N	125° 46' E	47065
Sin'gye	38° 30' N	126° 32' E	47067
Sinp'o	40° 02' N	128° 11' E	47046
Sinŭiju	40° 06' N	124° 23' E	47035
Sŏnbong	42° 19' N	130° 24' E	47003
Sup'ung	40° 27' N	124° 56' E	47028
Wŏnsan	39° 11' N	127° 26' E	47055
Yangdŏk	39° 10' N	126° 50' E	47052

** Upper-air capable station*

Aside from the data collected from this network of observation stations the HMS receives data from sister organizations in Khabarovsk, Russia and Beijing, China, as well as data acquired from Chinese, Japanese and U.S. weather satellites. The DPRK has been a member of the World Meteorological Organization (WMO) since 1975 and a member of the International Oceanographic Commission since December 1978.[15]

Reported HMS departments include the,

- External Relations (a.k.a., Department of International Relations) that is responsible for submitting requests for hardware and software assistance to the WMO and maintaining links with sister organizations in friendly nations.
- Meteorological Department
- Observation Department
- Oceanographic Department

Open sources refer to the following institutes subordinate to the HMS,[16]

- Central Forecasting Institute (a.k.a., Central Weather Forecast Institute)
- Central Hydrology Institute (a.k.a, Hydrological Institute)
- Central Information Center (a.k.a., Central Distribution Center of Hydrometeorological and Oceanographic Information)
- Central Meteorological Institute (a.k.a., Central Meteorological Research Institute)
- East Sea Oceanographic Research Institute (a.k.a., Oceanographic Research Institute of the East Korea Sea)

- Hydrometeorology Institute, Oceanography Institute
- West Sea Oceanographic Research Institute (a.k.a., Oceanographic Research Institute of the East Korea Sea)

The nature of the relationship between the HMS and the Advanced Weather School, located in P'yŏngyang, P'yŏngyang-si, is presently unclear.

The HMS's meteorological satellite ground station was completed in August 1990 with the assistance of the U.N. Development Program (UNDP). During 2005 it was upgraded with assistance from the WMO and is capable of receiving and processing data from Japanese (e.g., Geostationary Meteorological and Multi-functional Transport), Chinese (e.g., Feng Yun) and U.S. (e.g., NOAA) satellites.[17]

Besides the HMS's satellite ground station the DPRK maintains a satellite ground station for communications in P'yŏngyang under the Ministry of Post and Telecommunications (some sources suggest that these two stations may be collocated and share infrastructure). The DPRK joined *Intersputnik* in 1984 and subsequently constructed this satellite ground station with Soviet assistance in 1986. By the early 1990s this ground station was upgraded by the French firm Alcatel (now Alcatel-Lucent) to be capable of telephone and video communications utilizing the *Intelsat* network. By the late 1990s the International Satellite Communication Bureau operated three telephone, 10 telex and one telegraph circuits. There was some discussion at that time concerning the construction of a second ground station in the Northeast city of Najin, but this apparently did not proceed.[18]

During 1999 the Ministry of Post and Telecommunications leased satellite bandwidth on Thailand's Thaicom 1a communication satellite and has subsequently leased bandwidth on other satellites. While International Satellite Communication Bureau has since expanded and now operates the International Communication Center, Pot'onggang-dong, P'yŏngyang, P'yŏngyang-si (39° 01' 36.94" N 125° 44' 04.66" E).[19]

A 2002 P'yŏngyang telephone book identifies a "Satellite Meteorology Data Center of the Earth Satellite Information Institute" as being subordinate to the Academy of Sciences.[20] Exactly how these organizations interface with the ground stations of the HMS or International Satellite Communication Bureau is presently unclear.

During the past twenty years the HMS has entered into a number of technical agreements with, and received material support to upgrade its capabilities and network from, the Soviet Union/Russia, China (i.e., China Meteorological Administration), the ROK (i.e., Korean Meteorological Association), United Kingdom (i.e., British Meteorology Office), the United Nations (e.g., UNDP and WMO) and others.[21]

For example, during January 2005 the State Meteorological Bureau of China donated equipment for weather news service and observation to the HMS.[22] The following year, during April 2006, the Ministry of Water Resources of China donated communications and hydrological measurement equipment to the HMS.[23] More recently, during 2009, the HMS entered into an exchange and cooperation agreement with the National Agency for Meteorology, Hydrology and Environment Monitoring of Mongolia.[24] Despite such agreements and assistance the director of the Climate and Water Department of the WMO, Avinash Tyagi, visited the DPRK during March 2011 and declared that the HMS's "…equipment and computers used for weather forecasting were in urgent need of replacement."[25]

Assessment

Notwithstanding 65 years of service and years of foreign assistance the HMS is woefully inferior in the collection, analysis, exploitation and dissemination of hydrological, oceanographic, meteorological and environmental information when compared to any of its neighbors. It remains heavily dependent upon them for the collection of long-range data and is completely dependent upon foreign satellite data. Despite these significant limitations the HMS occupies an important position in the DPRK's economy and fulfills a vital support mission for the General Staff Department's Geological, Nuclear-Chemical Defense and Ballistic Missile Training Guidance Bureaus, as well as the Korean People's Air Force and Navy. It has an active interest in the development of satellites and there associated launch vehicles. Additionally, the HMS likely plays a vital support role during all satellite launches.

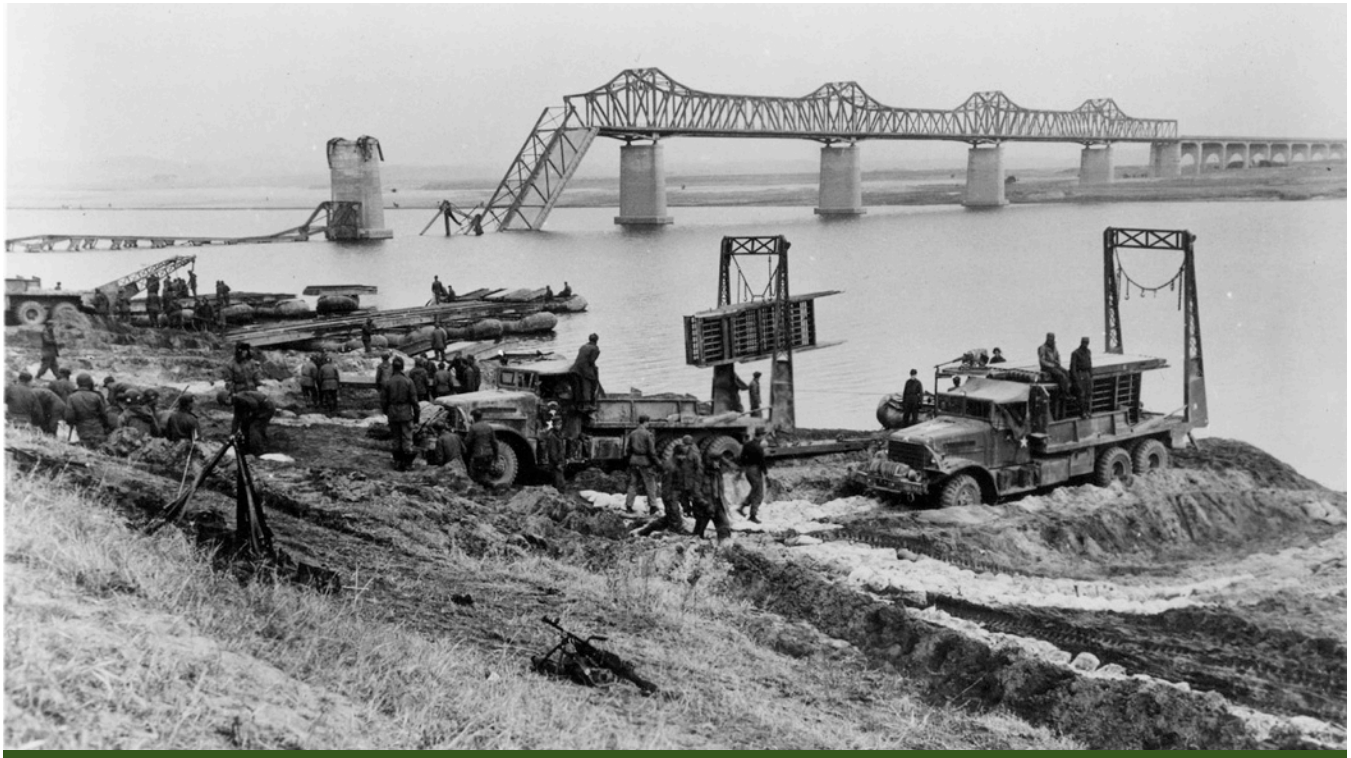
Han-gang Bridges

The past articles in *KPA Journal* concerning KPA engineer river crossing units, bridging operations and the Han-gang Bridges continue to generate considerable reader interest. What follows are several contemporaneous photographs of the Han-gang bridges.

The first is a U.S. Army photograph provided by the Harry S. Truman Library.

The remaining images are from Michael Webster's *Picasa Web Album* and are of RAAF Flight Sergeant Leon Murtagh's experiences during the Korean War. These and other photographs can be found at, http://picasaweb.google.com/balegang/FsgtLeonMurtaghRAAFC47DakotaPilotKoreanWarCareerPhotos19481953#5223166925770098034.

An interesting pre-war photograph of the Hang-gang Bridges can be found at the following URL, http://www.flickr.com/photos/kernbeisser/3781922408/. The caption states that it is of the "Kanko Iron Bridge." As



December 9, 1950, Members of the 55th Engineer Treadway Bridge Battalion, I Corps, construct a floating bridge across the Han-gang. The western most railroad bridge is seen in the background. (U.S. Army, Courtesy of Harry S. Truman Library)

A view looking north of the road bridge over the Han-gang, taken after the recapture of Seoul. (Flt. Sgt. Leon Murtagh, RAAF via Michael Webster)

A British Centurion tank facing north at the southern end of the road bridge over the Han-gang. (Flt. Sgt. Leon Murtagh, RAAF via Michael Webster)

A view looking southwest, on approach to the K-16 Airfield (situated on island) of the partially repaired Han-gang bridges after the recapture of Seoul. (Flt. Sgt. Leon Murtagh, RAAF via Michael Webster)

A view looking southwest, on approach to the K-16 Airfield (situated on island) of the partially repaired Han-gang rail bridges. (Flt. Sgt. Leon Murtagh, RAAF via Michael Webster)

many readers are aware Kankŏ is the pre-war Japanese name for Hamhung. It was, however, also the Japanese name for the Han-gang.

The following URL is for the official site of the U.S. Army engineers in Korea and contains numerous images of both the Han-gang bridges and UNC bridging operations, http://www.history.army.mil/photos/Korea/kwengin/default.htm.

Editor's Notes

First, a quick note of explanation to all the readers who have emailed me during the past two months, this issue of *KPA Journal*, and next (i.e., April), are delayed due to travel commitments and the need to finish a three-month-long research project. Thank you all for your concern and interest.

I would like to again thank *DigitalGlobe* for permission to use the remarkable satellite imagery that appears in the article covering the new version of the SANG-O SSC. Additional thanks is due Michael Webster for freely sharing Flight Sergeant Leon Murtagh's wartime photographs of the Han-gang bridges and Don Hillger for the scan of the HMS commemorative stamp, which can be found at http://rammb.cira.colostate.edu/dev/hillger/KoreaNorth.3730.jpg.

Finally, I am indebted to Kim Ji Eun, Michael Madden and Dwight Rider for their assistance in the preparation of various aspects of this issue.

As always all comments, corrections and criticisms are welcomed. I continue to solicit your thoughts and suggestions on how to both improve *KPA Journal* and to tailor it more closely to your needs and interests, as well as those of the organizations you represent. Please feel free to contact me with any recommendations.

Please feel free to share *KPA Journal* with your colleagues and friends. If you are a new reader and would like to be added to the *KPA Journal* mailing list please do so by sending me an email via the *Contact* feature on the website (www.kpajournal.com).

Thank you, one-and-all for your emails, encouragement and support.

—Joseph S. Bermudez Jr.

Endnotes

1 An earlier version of this article appeared in *Jane's Defence Weekly* on 30 March 2011 (http://jdw.janes.com/). Since that time additional information has become available and this version both updates and expands that original work.

2 Interview data acquired by Joseph S. Bermudez Jr.; "N.Korea Steps Up Submarine Drills," *Chosun Ilbo*, April 7, 2011, http://english.chosun.com/site/data/html_dir/2011/04/07/2011040701064.html; "N. Korea Builds up Submarine Force," *Chosun Ilbo*, March 21, 2011, http://english.chosun.com/site/data/html_dir/2011/03/21/2011032100584.html; and Bermudez Jr., Joseph S. *North Korean Special Forces—Second Edition*, Annapolis: U.S. Naval Institute Press, November 1997, pp. 161-167. A SSC is a submarine of less than 500 tons submerged displacement, while a SSM is less than 150 tons submerged displacement. A SSA is an auxiliary submarine used for noncombatant roles such as training, trials, etc. Wertheim, Eric. *Naval Institute Guide to Combat Fleets of the World*, Annapolis: U.S. Naval Institute Press, 2007, p. xxii.

3 While the indigenous class designations for DPRK manufactured submarines are unknown they have been assigned Korean language reporting names by the ROK and U.S. These names are based upon fish names. Therefore, SANG-O = shark, YON-O = salmon, etc. "O" means fish. For example "Go-deung-o" is mackerel, "Chong-o" is herring, "Da-rang-o" (or Cham-chi) is tuna, etc.

4 Interview data acquired by Joseph S. Bermudez Jr.; U.S. Navy, *Worldwide Submarine Challenges*: 1996, Office of Naval Intelligence, Washington, D.C., 1996, pp. 30-31; *Jane's Fighting Ships*, 1990-present, London: Jane's Information Group, 1990-present.

5 Bermudez Jr., Joseph S. *North Korean Special Forces—Second Edition*, Annapolis: U.S. Naval Institute Press, November 1997, pp. 161-167; and Starr, Barbara. "Off-the-Shelf Infiltrator," *Jane's Defence Weekly*, October 23, 1996.

6 Interview data acquired by Joseph S. Bermudez Jr.; Bermudez Jr., Joseph S. *North Korean Special Forces—Second Edition*, Annapolis: U.S. Naval Institute Press, November 1997, pp. 161-167; and "Infiltrator, Defector News Conference," *Yonhap*, October 29, 1996.

[7] Republic of Korea, *Defense White Paper*, Seoul: Ministry of National Defense, 1990–2010.

[8] "Asiatic Satellite Air Arms Are Still Growing," *Air Intelligence Digest*, Vol. 7, No. 5, May 1954, pp. 14-16; and *FEAF Intelligence Roundup*, Vols. 4 and 5, 1953-1954, various issues.

[9] "DPRK Hydrometeorological Service Profiled," *FBIS Report*, September 22, 2005, *Open Source Center*; and *The Development of Marine Sciences*, Paris: United Nations Educational, Scientific and Cultural Organization, Technical Report, RP/1981-1983/2/7.4/04, 1982, pp. 9. When involved in WMO activities representatives of the HMS identify themselves as being from the "State Hydrometeorological Administration." For example, *List of Participants WMO Technical Conference of Meteorological and Environmental Instruments and Methods of Observation (TECO-2010)*, August 20, 2010, www.hydrometeoindustry.org/.../TECO-2010-PARTICIPANTS.pdf, accessed February 7, 2010.

[10] "Foreign Aid Helps Maintain, Upgrade DPRK Weather Stations," *OSC Report*, 27 June 2006, *Open Source Center*; and "DPRK Hydrometeorological Service Profiled," *FBIS Report*, September 22, 2005, *Open Source Center*.

[11] Ibid.

[12] "DPRK Meteorological Official Interviewed on Launch, Plans for Future Satellites," *Choson Sinbo*, April 6, 2009, *Open Source Center*.

[13] "Foreign Aid Helps Maintain, Upgrade DPRK Weather Stations," *OSC Report*, 27 June 2006, *Open Source Center*; and "DPRK Hydrometeorological Service Profiled," *FBIS Report*, September 22, 2005, *Open Source Center*.

[14] Ibid.

[15] *The Development of Marine Sciences*, Paris: United Nations Educational, Scientific and Cultural Organization, Technical Report, RP/1981-1983/2/7.4/04, 1982.

[16] The West Sea and East Sea Oceanographic Research Institutes were established during 1963 and 1964, respectively. *The Development of Marine Sciences*, Paris: United Nations Educational, Scientific and Cultural Organization, Technical Report, RP/1981-1983/2/7.4/04, 1982, pp. 3-7.

[17] "Foreign Aid Helps Maintain, Upgrade DPRK Weather Stations," *OSC Report*, 27 June 2006, *Open Source Center*; and "Meteorological Satellite Earth Station Built," *KCNA*, 27 August 1990, *Foreign Broadcast Information Service*.

[18] "Anniversary of Kim Chong-il Guidance to Earth Station Marked," *KCNA*, 15 March 1996, *Foreign Broadcast Information Service*; "Foreign Firms Compete for DPRK Communications Business," *Hanguk Ilbo*, 15 January 1996, p. 13, *Foreign Broadcast Information Service*; "DPRK Use of Communications Satellite Planned," *Asahi Evening News*, 18 September 1990, p. 3, *Foreign Broadcast Information Service*; and "Soviet Satellite Tracking Station Built Near Pyongyang," *Tonga-Ilbo*, December 27, 1984, p. 4, *Foreign Broadcast Information Service*. When originally established in 1971, the International Organization of Space Communications (*Intersputnik*) was an international satellite communications organization for communist nations. Today, it has 25 member states. Information on *Intersputnik* can be found at http://intersputnik.com/.

[19] "DPRK May Launch Missile 'End of Next Month,'" *Yonhap*, July 9, 1999. Information concerning the Thaicom family of communications satellites can be found at: http://www.mlesat.com/Thaicom.html; http://www.lyngsat.com/thai1.html; and http://www.skyrocket.de/space/doc_sdat/thaicom-1.htm.

[20] "Discovering Aspects of S&T Infrastructure by Reading the Telephone Book," *OSC Analysis*, 31 December 2002, *Open Source Center*.

[21] "Foreign Aid Helps Maintain, Upgrade DPRK Weather Stations," *OSC Report*, 27 June 2006, *Open Source Center*; "DPRK Hydrometeorological Service Profiled," *FBIS Report*, September 22, 2005, *Open Source Center*; "World Meteorological Day Observed," *KCNA*, 23 March 2005; "North Korea Turning To Germany for Cooperation in Science and Technology," *FBIS Report*, 27 September 2004, *Open Source Center*; "N. Korea Urges Regional Cooperation on Weather Data," *Kyodo*, August 31, 2000; "ROK White Paper Examines DPRK Information-Telecommunications System," *Kukka*, 30 June 2000, pp. 379-393, *Open Source Center*; "DPRK Exchange Notes on Possible Information Trade," *Yonhap*, 23 April 1998; "Government Trying to Establish Direct Weather Channel with NK," *Korea Times*, April 12, 1998; "DPRK Meteorological Institute Official on 'Unusual' Weather," *Foreign Broadcast Information Service*, 28 May 1997, *Foreign Broadcast Information Service*; "ROK Provides 238 Million Dollars in Aid to DPRK Since 1995," *Chosun Ilbo*, 12 April 1997, *Foreign Broadcast Information Service*; "Anniversary of Kim Chong-il Guidance to Earth Station Marked," *KCNA*, 15 March 1996, *Foreign Broadcast Information Service*; "Foreign Firms Compete for DPRK Communications Business," *Hanguk Ilbo*, 15 January 1996, p. 13, *Foreign Broadcast Information Service*; "Hydrometeorological Pact Signed With PRC," *KCNA*, 25 September 1995, *Foreign Broadcast Information Service*; Yong, Nam-gung. *North Korea's Industrial Infrastructure*, Research Report No. 1994-05, Seoul: North Korea Research Institute, 1994, *Foreign Broadcast Information Service*; "DPRK Use of Communications Satellite Planned," *Asahi Evening News*, 18 September 1990, p. 3, *Foreign Broadcast Information Service*; "Meteorological Satellite Earth Station Built," *KCNA*, 27 August 1990, *Foreign Broadcast Information Service*; and "Soviet Satellite Tracking Station Built Near Pyongyang," *Tonga-Ilbo*, December 27, 1984, p. 4, *Joint Publications Research Center*.

[22] "Weather Equipment Donated to DPRK by China," *KCNA*, January 25, 2005, http://www.kcna.co.jp.

[23] "China Donates Equipment to Korean Hydrometeorological Service," *KCNA*, April 17, 2006, http://www.kcna.co.jp/item/2006/200604/news04/18.htm.

[24] "Mongolia and North Korea Cooperate on hydrometeorology," *Environment and Development*, February 23, 2009, http://www.mongolia-web.com/environment-and-development/2238-mongolia-and-north-korea-cooperate-on-hydro-meteorology, accessed April 1, 2011.

[25] "UN Team in N. Korea to Look at Weather Forecast System," *Arirang*, March 19, 2011, http://www.arirang.co.kr/News/News_View.asp?nseq=113914&code=Ne2&category=2; and Kim, Se-jeong. "N. Korea in Need of New Meteorological Equipment," *Korea Times*, April 1, 2011, http://www.koreatimes.co.kr/www/news/nation/2011/04/113_84300.html.